UNIVERSITY OF CALIFORNIA.

AGRICULTURAL EXPERIMENT STATION.

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Spray and Band Treatments for the Codlin Moth.

During the summer of 1887 careful observations have been made of the efficacy of spraying with arsenical compounds and of the band treatment for the reduction of the codlin moth, *Carpocapsa pomonella*. This insect appeared in the University orchard a few years ago, and during last year was quite abundant. The success reported by Prof. S. A. Forbes, State Entomologist of Illinois, in spraying with Paris green for the destruction of the larvæ as soon as it begins to feed in the calyx of the apple, and similarly good results reported by several California apple-growers, suggested that a set of experiments with arsenic and its compounds should be made in the University orchard, where more time could be given to an accurate account of results than a busy fruit grower could devote to such work. As it was known that W. G. Klee, State Inspector of Fruit Pests, was conducting similar experiments on his own farm and was keeping accounts of experiments by others, it was thought best that the University experiment should be given a direction similar to his, that the results of all experiments could finally be brought together and serve for purposes of a wide generalization. For this purpose Mr. Klee was invited to prescribe the applications to be made. He did so, and assisted personally in the preparation and application of the poisons—a service for which we make due acknowledgment.

Application was made of three substances, white arsenic, Paris green and London purple, and each in different strengths, as will be specified in the tables which will be given below. The white arsenic was dissolved in hot water; the Paris green and London purple were kept as thoroughly stirred as possible while being drawn up by the pump. The drenching of the trees was quite complete, the spray being especially directed upon the clusters of fruit which in most cases were still upright, so that the drops of the liquid were caught and held in the calyx end. There was, of course, much difference in the size of the fruit, as the orchard comprises a large collection of summer, fall and winter fruit. Trees were selected, however, as carefully as possible, which had the fruit of the best stage of growth, say from the size of a pea to that of a small marble, at the time of the first spraying.

The tables will show that in most cases three applications were given, all within 30 days from May 31. During that period the records of the University meteorological observatory show that rain was measured but once, and then but one-twentieth of an inch, and in the month of June there was but a sprinkle, even less in amount, so that the weather was perfect for the retention of the poison on the fruit.

The University orchard is planted with two trees of each variety, and in these experiments one was sprayed and the other reserved without treatment, so that a comparison, each tree with one of its own variety and age, could be made. The orchard was guarded in such a way that no outside interference could be had with the fruit. Twice a week all the fruit which fell from the sprayed trees and from the check trees, unsprayed, was examined and careful entry made in a book prepared for the purpose, of all worms found in the fruit, of all fruit from which the worms had escaped, and the number of worms found under the bands of sack-cloth, which were placed upon all the trees. This plan of procedure was faithfully carried out until November 1st, when all the fruit remaining at that time was removed from the trees, examined for worms and the experiment closed.

The following tables show a summary of results. The full report, with details of procedure and deductions therefrom, is reserved for our next annual report.

Paris Green—One Pound to 160 Gallons of Water.

Fruit.	Variety.	Dates of Application.	Apparent Effects.	Worms in fruit and under bands on treated tree.	Worms in fruit and under bands on untreated tree.
Pear....	Nouveau Poiteau	May 3d and 19th.....	None.....	10	23
Pear....	Nantais.....	May 3d and 19th, and one later.	None.....	4	4
Apple...	Red Canada.....	May 3d and 19th, and June 1st..	None.....	4	35
			Totals.....	18	62
			Gain, per cent ..	71	

Paris Green—One Pound to 320 Gallons of Water.

Pear....	Duchesse Precoce.....	May 3d.....	None.....	3	8
Pear....	Dr. Reeder.....	May 3d and 19th.....	None.....	1	27
Pear....	Chaptal.....	May 3d and 19th, and June 1st..	None.....	6	1
Apple...	Duchess Oldenburg.....	May 3d and 19th.....	None.....	0	1
Apple...	Fameuse.....	May 3d and 19th, and June 1st..	None.....	9	4
			Totals.....	19	41
			Gain, per cent ...	54	

Paris Green—One Pound to 160 Gallons of Water, with Two Pounds of Soap.

Pear....	Beurre Gris d'niver	May 3d and 19th*.....	None.....	5	2
Apple...	Wells' Sweet	May 3d.....	None.....	3	3
Apple...	Duchesse Mignonne....	May 3d and 19th.....	None.....	1	13
	*Considerable settling in can.		Totals.....	9	18
			Gain, per cent....	50	

London Purple—One Pound to 160 Gallons of Water.

Pear....	DeTongrest.....	May 3d.....	Badly injured.....	13	21
Pear....	St. Michael Archangel..	May 3 l.....	Badly injured..... ...	4	0
Apple..	Disharoon	May 3d and 19th, and June 1st..	Little damage.....	9	9
Apple..	Yopps' Favorite.....	May 3d and 19th, and June 1st'.	Little damage.....	5	7
	†Two and one-half gallons of wash used		Totals.....	31	37
	*Strength of second and third sprayings, 1 lb. to 220 galls. water.		Gain, per cent....	16⅔	

London Purple—One Pound to 80 Gallons of Water.

Pear....	Emile de Heyst.....	May 3d and 17th,* and June 1st*	Fruit and foliage damaged	19	6
Pear....	Madame Treyve.....	May 3d and May 18th*.....	Fruit and foliage damaged	0	24
Pear....	Augustus Dana.....	May 3d.....	Fruit and foliage damaged	0	4
Apple...	Seek No Further.....	May 3d.....	Badly injured.....	16	51
	*Strength of second and third sprayings, 1 lb. to 220 galls. water.		Totals.....	35	85
			Gain, per cent....	59	

White Arsenic—One Pound to 320 Gallons of Hot Water.

Pear....	Callebasse Monstreuse .	May 3d.....	Foliage little damaged....	4	3
Apple...	Grimes' Golden Pippin.	May 3d and 19th.....	....	1	0

White Arsenic—One Pound to 480 Gallons of Water.

Pear....	Ott.....	May 3d.....	None.....	0	1
Apple...	Early Joe.....	May 3d.....	None.....	0	17

White Arsenic—One Pound to 640 Gallons of Water—with Soap.

Pear....	Napoleon.....	May 3d and 20th, and June 1st..	None.....	1	3
Apple...	Hall.....	May 3 l and 19th, and June 1st..	None.....	0	No check.

These applications were all made to effect the first brood of the moth. The figures of infested fruit are all small, for in Berkeley, as in most places along the coast, at least, the first brood of the moth was unusually small this year. This fact would not necessarily interfere with the percentage of gain by the treatment.

In the case of the white arsenic the record of worms is so small and the result so contradictory in that the stronger wash gave a percentage of loss while the weaker gave a percentage of gain, the inference is that the worms were not on hand to be killed. Undoubtedly allowance must be made for chances of this kind in all experiments including only a tree or two. One codlin moth is said to deposit anywhere from 50 to 200 eggs, and so a single moth by presence or absence might produce a great difference in an experiment. When the pest is abundant there is of course less danger of such results.

The experiments with Paris green and London purple are more satisfactory, as more trees are included, and worms are found on all, which shows that the moth visited the trees more freely. The percentages of gain must be considered very satisfactory, and the stronger applications, barring injury to foliage, produce the best results. In the case of Paris green, the application of a wash with one pound of Paris green to 160 gallons of water must be regarded as very satisfactory, giving a gain of over 70 per cent of good apples and pears and not doing any injury to foliage or fruit. The susceptibility of trees to injury seems to vary with the kind of fruit and the variety as well, and may be affected by other conditions. This is a matter which needs full investigation.

Examination of the Band Treatment.

In order to determine some points about the efficacy of banding apple and pear trees for the destruction of the larvæ of the codlin moth, an accurate record has been kept in the University orchard during the past season. The bands were put on early and consisted of strips of old sacks. The strips were five or six inches wide; the ends were allowed to lap well and the band was secured by a string tied around near the center so as to furnish crevices at both the upper and lower edges, to accommodate worms coming from either direction. All these bands were removed on a certain day each week, the larvæ counted and killed and the bands replaced. At the same time all the fallen fruit was gathered, examined for worms, or to see if worms had escaped, and records of these facts kept separately. The full statement of this investigation is not yet ready, but a brief summary of leading results may be given as follows:

Row No.		Larvæ under bands.	Larvæ in fruit.	Other damaged fruit.	No. trees in row.
Pears	9	31	27	71	22
	10	42	58	142	35
	11	73	42	127	37
	12	125	34	180	38
	13	56	34	115	38
	14	137	34	226	39
	15	83	54	226	38
	16	45	19	95	15
Apples	16	4	1	19	17
	17	91	48	202	32
	18	57	14	102	25
	19	89	89	446	24
	20	163	61	320	26
	21	83	40	153	25
	22	32	22	81	21
	23	74	31	191	16
	24	3	0	8	9
Totals		1188	608	2704	457

This summary shows that while 2704 apples and pears were found from which worms had escaped, there were found under the bands but 1188, or 44 per cent, the remaining 56 per cent includes worms which found nesting-places elsewhere or perished. The assistant, who kept the record of this experiment, assures me that he believes many of these were eaten by birds which were always working over the ground while he was in the orchard. The others must have concealed themselves under clods to spin their cocoons, for there is no loose bark on the trees, and no rubbish or fences in which they could hide. It would seem from this experiment that the bands catch less than half of the worms which gain access to the fruit, and yet the destruction of this proportion of fully fed and healthy larvæ must be considered very satisfactory. As all the losses by birds or other enemies of the worm by accident and by other agencies which destroy insect life must be taken from the percentage of worms not found under the bands, it will be seen that the old method of treatment is still one of the most effective that can be employed.

E. J. WICKSON.

Berkeley, Nov. 19, 1887.

Difficult Fermentations.

Complaints of difficult fermentations have been very general during the vintage just past, and a great deal of red wine especially has refused to "go dry" within the usual or any reasonable limit of time. It has long been my conviction that in the vast majority of cases the difficulties complained of arise from excessive heat during and particularly at the beginning

of fermentation. At the end of last year's vintage, a number of comparative fermentations were made at the University Viticultural Laboratory, partly with a view to testing this question; but it being late in the season, the only grapes available for the purpose, viz., second-crop Zinfandel, were not of a character to test the point, having high acid (.65) and low sugar (21.6); and the high temperature attained seemed to accelerate, rather than retard, the fermenting process. This season, 16 fermentation experiments, parallel with those of last year, have been made, and the results of some of these throw so much light upon the causes of "difficult fermentations" that it seems proper to give publicity to them in advance of any detailed report on the whole series.

Equal charges of 200 pounds each were fermented in 50-gallon tanks, save that in the hot fermentations 25 pounds more were used, in order that the rise of temperature might be favored by greater mass. In the hot chamber a temperature of between 85 and 90 degrees was maintained; while in the fermenting-room in which the other charges were being treated, the temperature was kept as nearly as possible at 75 degrees. The grape employed was a fine lot of Carignane, courteously donated for the purpose by A. J. Salazar Jr., of Mission San Jose. The must showed 25.75 per cent by spindle, and .53 per cent, or a little over five *pro mille*, of acid.

Of the tanks in the fermenting-room, filled with mash at 63 degrees, three, treated by usual methods, went practically dry and were sent to press on the seventh day; the first to finish being the one with "floating cover and twice-daily stirring," the method adopted in the laboratory for general purposes. The highest temperature reached by any of these was 95 degrees.

On that day (7th) the two tanks in the hot chamber, which had in setting been warmed up to 86 degrees and at first fermented most violently, and in 43 hours attained a maximum temperature of 106 degrees, had come down to very slow movement; the actual solid contents were found to be a little over 12 per cent. It being obvious that they would not "go through" under existing conditions, the two charges were divided into four parts, of which one was left in the hot chamber and treated as before, in order to observe the outcome. The others served for experiments to test the best mode of reviving the fermentation in the lower temperature of the fermenting-room.

One portion received 1½ per cent of pomace, freshly pressed from one of the other tanks, and well stirred in; floating cover put on and well stirred three times daily. Fermentation soon revived, and went on slowly, but steadily, until the seventh day, when the charge was sent to press, practically dry.

One, a double portion of 19½ gallons, was mixed with 2½ gallons of condensed Zinfandel must set at 21 per cent with distilled water, and having been allowed to pass into active fermentation before mixing with the "stuck" mash. Fermentation soon set in, and slowly but steadily carried it to dryness on the 17th day, being eight days from the time the fresh must was added.

The fourth portion was left without any addition, but was from the time it left the hot chamber vigorously *aerated*, by means of an air pump, three times a day. Fermentation soon revived, and the charge went dry and was sent to press at the end of the sixth day from the time it was removed from the hot chamber, being nearly two days in advance of the other tanks treated with pomace and must respectively, but aerated only by ordinary "foulage" with a cross-peg stirrer.

It thus appears that *simple aeration, without the addition of any new yeast*, was at that stage of the mash that had "stuck" in consequence of overheating, *the most effectual mode of reviving and completing the fermentation.* The pressed wine had the same acid-percentage as the orginal must, and is free from acetic taint.

As for the portion that remained in the hot chamber, it continued a feeble action for some time, but on the 14th day from the setting of the mash it had practically stopped. It was then removed to the fermenting-room, and after cooling down to 75 degrees and aerating by the pump, a faint revival of fermentation took place for 36 hours. Then the cap sank and the tank was "dead." The day after, the odor and taste of milk-sourness became so patent that the mess was sent to press with over nine per cent of solids, as a dead failure, on the 17th day; a woful, but in practice but too familiar example of the results of hot fermentations.

I reserve for the future a detailed discussion of the subject, in connection with other experiments, but the main points illustrated may be briefly thus stated:

1. While musts of *low sugar* contents and *high acid* may be successfully rushed through to dryness at a high temperature and make a sound wine, the same is not true of those having *high sugar* and *low acid;* the margin of difference between the two cases is a very narrow one, both as to temperature, acid and sugar, and hence a few days of hot "norther" may easily turn the scale.

2. When the temperature has not been excessively high, and not maintained too long, simple aeration by means of a pump or blower may revive it *at a lower temperature.* Sound pomace, or fresh fermenting must, are additions to be used when available or necessary.

While these facts and principles are not new to experts, I have thought it worth while to re-establish them by facts and figures, and to offer them as a substitute for the supposed mysteries of "difficult fermentations" that have so vexed our winemakers. The vatting of hot and overripe grapes and the omission of proper aeration of the mass, while allowing the surface to acetify, are responsible for nine-tenths of all unsoundness in California wines.

E. W. HILGARD.

Berkeley, Nov. 17, 1887.